

## METHOD, APPARATUS AND SYSTEM TO MITIGATE NOISE DURING UNLOADING OF CONTAINERS

### BACKGROUND OF THE INVENTION

#### Field of the Invention

The present invention relates to the field of noise suppression, and more particularly to methods, apparatus and systems for retrofitting existing refuse containers and hauling systems to reduce noise during unloading of such containers, as well as constructing new equipment to incorporate the invention.

#### Description of the Related Art

Presently, commercial refuse containers are constructed from steel, and come in a variety of form factors, the most prevalent being 3 and 4 cubic yard sizes. Early advancements in the art of refuse handling included the adaptation of such containers to be handled by lifting equipment. In particular, refuse containers were fitted with fork pockets so as to receive adjustable fork assemblies mounted to mobile refuse collection vehicles. By utilizing collection vehicles equipped with lifting forks, and servicing containers fitted with fork pockets, significant gains in speed, safety, and efficiency have been realized. However, an unintended consequence has been the noise resulting from the engagement of the container by the forks as well as the removal of refuse from the container when shaken (as is often times the case) to ensure that all debris has been removed.

A principal reason for the significant noise emanating from the container is the fact that the container is nearly always a hollow steel structure. Operational noises from both the vehicle and the container during refuse removal are amplified by the volume defined by the container. While constructing a container from different material may solve the noise problem, the process would likely have to be phased.

In view of the foregoing, it is desirable to incorporate a noise suppression scheme so that existing steel refuse containers can continue to be used but are

modified to reduce the amplification and/or transmission of vibrations that occur during unloading of the container by a fork equipped vehicle.

## BRIEF SUMMARY OF THE INVENTION

The invention is directed on the one hand to retrofitting existing containers that are adapted for use with vehicles having lifting forks for elevating and maneuvering such containers, as well as retrofitting the vehicle forks, and on the other hand to constructing new equipment to include the invention. An apparatus according to the invention comprises a liner formed from a vibration absorbing material for insertion into a pocket associated with a container. Alternatively to or in conjunction with the liner, either a glove formed from a vibration absorbing material can be inserted over a lifting fork on a fork bearing, lifting apparatus, or a rail formed from a vibration absorbing material can be fitted to at least a portion of a lifting fork on the fork bearing, lifting apparatus. In all cases, the liner or glove/rail is preferably constructed from a durable material having very low vibration transmission properties and/or high damping properties. The invention is also directed to methods relating to the use and incorporation of the apparatus, and systems incorporating more than one component thereof.

In a preferred embodiment, ultra high molecular weight (UHMW) polyethylene is chosen as the vibration absorbing material. However, it is to be noted that the invention includes metallic, non-metallic, and hybrid materials, with the ultimate selection criteria resulting in a reduction in vibration transmission between the container and the lifting equipment. Thus, a vibration absorbing material impregnated with metallic elements is within the scope of this invention as would be a laminate construction of metallic and non-metallic strips.

The liner and glove embodiments of the invention are preferably formed to frictionally fit, respectively, within an existing container pocket or over an existing lifting fork. While such a fit is sufficient to enable the invention (alternative means to secure the liner and/or glove are contemplated such as by use of adhesives, fasteners, and the like), each apparatus preferably includes means for preventing the separation of one or

more apparatus from the supporting structure, to prevent the unintentional dislodgment of a liner or glove.

The liner embodiment of the invention is formed to have outer dimensions that are sufficient to frictionally fit, with or without additional treatment, within the container pocket, and internal dimensions sufficient to receive an intended lifting fork, with or without a glove. Thus a cylinder of material is formed by, for example extrusion or rotational molding, to specifically fit a given container pocket.

A feature of the liner is the presence of a lip that extends laterally beyond the cylinder at an end to prevent the liner from exiting the container pocket if pushed by an entering fork. Another feature of the invention is the presence of a bumper that extends unidirectionally from the cylinder at the lip. The bumper serves to insulate the container structure from any lifting fork supporting structure such as a cross member or similar element.

The glove embodiment of the invention is similarly formed to have specific dimensions based upon the structure to which it will be attached. In particular, the internal dimensions of the cylinder that comprises the glove are sufficient to fit over the targeted section of a lifting fork. If the lifting fork also includes a distal end cap, the glove is preferably heated so that it enlarges sufficiently to pass over the cap and returns to a nominal size after cooling.

In the rail embodiment, the lifting fork is preferably modified so as to receive the rail element yet preferably maintain its original dimensions. Thus, if the working length of the rail is 30" x 1", a similarly sized segment of the load bearing portion of the fork is removed to receive the rail. A similar modification can be made with respect to the opposite or lower side of the lifting fork, depending upon design considerations.

A feature of the rail embodiment is a symmetrical or asymmetrical lateral enlargement of its width beyond the corresponding width of the lifting fork. In this manner, lateral movement of a container being engaged by the equipped lifting fork will be modulated by the vibration dampening rail as opposed to the lateral sides of the

lifting fork, which do not have vibration dampening properties. Similarly, increased or decreased rail depths are also considered to be viable modifications.

In all embodiments, the internal and external surface characteristics may be other than smooth. Thus, the internal surface of the glove embodiment or the external surface of the liner embodiment may have a ribbed character to enhance the friction fit between these components and a fork or container pocket, respectively. Similarly, the exterior surface of the glove embodiment and the rail embodiment, or the internal surface of the liner embodiment may be ribbed.

#### BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWING(S)

Figure 1 is a perspective view of a glove embodiment in accordance with principles of the present invention for covering a fork component associated with a refuse transportation vehicle.

Figure 2 is a perspective view of the glove of Figure 1 shown mounted to a fork having an end cap for securing the glove on the fork in accordance with principles of the present invention.

Figure 3 is a perspective view of a fork modified to receive a rail embodiment as an alternative to the glove embodiment in accordance with principles of the present invention.

Figure 4 is an exploded perspective view of the rail embodiment of Figure 3 in accordance with principles of the present invention.

Figure 5 is a representative cross section elevation view of the rail embodiment of Figure 3 in accordance with principles of the present invention.

Figure 6 is an exploded perspective view of an alternative rail embodiment to that shown in Figure 3 in accordance with principles of the present invention.

Figure 7 is an exploded perspective view of a refuse container showing a liner and illustrating the placement of the liner in the pockets of the container in accordance with principles of the present invention.

Figure 8 is a partial perspective view of the front portion of a liner highlighting a lip to prevent unintended forward movement of the liner in the pocket and a bumper to reduce impact during insertion of a fork assembly.

## DETAILED DESCRIPTION OF THE INVENTION

The following discussion is presented to enable a person skilled in the art to make and use the invention. Various modifications to the preferred embodiment will be readily apparent to those skilled in the art, and the generic principles herein may be applied to other embodiments and applications without departing from the spirit and scope of the present invention as defined by the appended claims. Thus, the present invention is not intended to be limited to the embodiment shown, but is to be accorded the widest scope consistent with the principles and features disclosed herein.

Turning to the several Figures wherein like numerals indicate like parts, and more particularly to Figures 1 and 2, fork glove 20 is shown. Glove 20 includes trailing portion 22 and leading portion 24, and is preferably constructed from 0.375 inch (0.9525 cm) UHMW polyethylene and is sized to frictionally fit over a target fork (as shown in Figure 1), which dimensions may vary from application to application. Thus, the inner dimensions of glove 20 are nominally the same as the exterior dimensions of fork 30 shown in Figure 2. Stated alternatively, any given lifting fork will have a progressive cross-sectional profile, which may or may not vary along the length of the lifting fork. The glove will have an inner cross-sectional profile complementary to that of the lifting fork when located thereon at a specific location, thus insuring a sufficient friction fit. And while a preferred means for attaching glove 20 to fork 30 is by way of a friction fit, other means for securing glove 20 to fork 30 are contemplated: adhesives, all forms of threaded fasteners, blind side fasteners, and mechanic constrictors such as clamps.

Alternatives to UHMW polyethylene include hard rubber, polytetrafluoroethylene (PTFE), or any other durable and vibration absorbing material. Vibration absorbing properties and wear resistance are the most significant design parameters for selecting a suitable material. Consequently, most resilient yet durable

materials are considered to be suitable for use. Moreover, materials capable of plastic deformation are desired for reasons set forth below.

The method of constructing glove 20 is largely a design consideration. Examples of construction methods include rotational molding, clam molding and extrusion molding.

In selected applications, distal lifting fork end cap 32 may be part of fork 30 as is shown in Figure 2. In such instances, end cap 32 incidentally operates to retain glove 20 on fork 30 should the frictional fit or other fastening means fail. It is to be noted, however, that leading portion 24 of glove 20 is prevented from forward movement by abutting end cap 32 while rearward movement is prevented by the frictional fit between trailing portion 22 of glove 20 against fork 30. Thus, the entire glove need not be in frictional engagement with the fork in order for the invention to function as desired.

To install glove 20, it is only necessary to insert trailing portion 22 over the target fork and urge it rearward thereon. Depending upon tolerances, it may be desirable and/or necessary to heat glove 20 to ensure it securely stays in its intended location, or to heat leading portion 24 of glove 20 to permit end cap 32 to pass there through, whereafter glove 20 is allowed to cool to its original form. Any heating operation such as by convection, conduction or radiation is suitable, as long as there is not permanent deformation of glove 20.

Heretofore all surfaces of fork 30 have been enveloped by vibration dampening material. An alternative means for insulating fork 30 is shown in Figure 3. Instead of a glove that encompasses the upper and lower surfaces as well as the inside and outside surfaces, rail 60a is substituted for a portion of upper surface 34 and rail 60b is substituted for a portion of lower surface 36. Each rail 60a and 60b is also constructed of UHMW polyethylene, PTFE or hard rubber, which are again considered vibration absorbing materials, and may be formed by extrusion or other suitable means. Each rail 60a and 60b preferably has a sectional thickness of about 1 inch (2.54 cm) and resides in a corresponding complementary recess 42 and 46 formed in fork 30. The creation of recesses 42 and 46 may occur during construction of new forks, or may

be created as a retrofit application using conventional material removal means. While this embodiment preferably uses both rails 60a and 60b, noise mitigation can be achieved by only using one or the other, and preferably rail 60a.

Even though there are no absolute limits for the maximum sectional thickness ( $T_r$ ) of either rail 60a or 60b, there are practical limits. For example, a thickness less than 0.25 inches may not provide the durability and insulative properties that are desired, while a thickness greater than 25% of the sectional thickness of fork 30 may compromise the structural integrity of the fork when the recess is formed. Consequently, ultimate determination of rail thickness is a design consideration.

The width ( $W_r$ ) of either rail 60a or 60b is selectable depending upon the desired effect. If lateral movement of a container pocket about fork 30 is to be addressed, the width of one or both rails can be modified to exceed the fork width for any given location. To avoid unintended contact between the pocket and a leading portion of a rail, it is advisable to have the leading portion of a rail not exceed the fork width at such a location. Thus, preferably a rail width may exceed fork 30 width at any location trailing the leading portion of a rail. In such an embodiment, the rail incorporates a taper or has a symmetrical or asymmetrical lateral convex contour.

Figures 4 and 5 illustrate the modifications necessary to make fork 30 as well as one means for attaching each rail 60a and 60b to fork 30 (such as by way of machine screws 70 locatable in threaded holes 72). Other means for securing rail 60a and/or rail 60b to fork 30 exist, and include use of adhesives, all forms of threaded fasteners, blind side fasteners, and the like.

Figure 6 illustrates an alternative embodiment of the present invention. Through experimentation, it has been determined that significant noise mitigation can be achieved if only the front or leading working portions of fork 30 are modified to include corresponding rails 61a and 61b. Thus, only a portion of each upper and lower working length "LW<sub>f</sub>" of fork 30 has a corresponding forward upper recess 44 and forward lower recess 48 to which are fastened respectively rails 61a and 61b. This embodiment is best shown in Figure 6. Again, because the areas of fork 30 that are exposed to the highest levels of impact loading benefit the most from use of the instant

technology, incorporation of upper rail 61a is more desirable than relying solely on lower rail 61b

The foregoing discussion related to modifications that can be made to fork 30. The invention is also directed to means for modifying an existing container to achieve noise mitigation. To this end, properly oriented liner 10, which is best shown in Figure 7, is inserted into pockets 82a and 82b of container 80 as illustrated. Each pocket 82a and 82b will have a progressive cross-sectional profile that may or may not vary over its length. In order to have a frictional fit between a pocket and a liner, the liner should have an outer complementary progressive cross-sectional profile. As with glove 20, liner 10 is preferably constructed from 0.375 inch UHMW polyethylene.

Pockets 82a and 82b are shown as being symmetrical (mirror images), therefore only one type of liner 10 is needed. Liner 10 includes a proximal end 12 and a distal end 18. To install liner 10, it is only necessary to insert distal end 18 into pocket 82a or 82b and urge it rearward. However, if asymmetric pockets are encountered, it will be necessary to fabricate a unique liner for each pocket, as those persons skilled in the art will appreciate.

As shown in Figure 8, a feature of a preferred embodiment is lip 14 extending around the periphery of proximal end 12. Because lip 14 has outer dimensions greater than the inner dimensions of pocket 82a or 82b, rearward translation of liner 10 is thereby prevented. While lip 14 represents a presently preferred means for preventing such unintentional movement, other means are contemplated such as the use of adhesives between the inner portions of pocket 82a or 82b and the outer portions of liner 10 and/or fasteners which attach pocket 82 with liner 10. These other means may also be used in conjunction with lip 14.

As further shown in Figure 8, another feature of liner 10 is the presence of bumper 16. Not only is vibration and hence noise produced by a fork 30 interacting with a pocket 82, but also when container 80 abruptly contacts a fork support assembly. To this end, distal end 18 extends from lip 14 so as to create a barrier between container 80 around the inlet of each pocket 82a and 82b.

The above description of illustrated embodiments of the invention is not intended to be exhaustive or to limit the invention to the precise form disclosed. While specific embodiments of, and examples for, the invention are described herein for illustrative purposes, equivalent modifications are possible within the scope of the invention, as those skilled within the relevant art will recognize. The teachings provided herein of the invention can be applied to other container systems, not necessary the exemplary containers described above. The various embodiments described above can be combined to provide further embodiments.

These and other changes can be made to the invention in light of the above detailed description. In general, in the following claims, the terms used should not be construed to limit the invention to the specific embodiments disclosed in the specification and the claims, but should be construed to include all container systems and lifting apparatus that operate under the cranes to provide a method and a system for mitigating noise during unloading, loading or movement of containers. Accordingly, the invention is not limited by the disclosure, but instead the scope of the invention is to be determined entirely by the following claims.

All of the above U.S. patents, U.S. patent application publications, U.S. patent applications, foreign patents, foreign patent applications and non-patent publications referred to in this specification and/or listed in the Application Data Sheet, are incorporated herein by reference, in their entirety.

From the foregoing it will be appreciated that, although specific embodiments of the invention have been described herein for purposes of illustration, various modifications may be made without deviating from the spirit and scope of the invention. Accordingly, the invention is not limited except as by the appended claims.